

2/pvls

Description

LIQUID LEVEL DETECTING APPARATUS

Technical Field

This invention relates to a liquid level detecting apparatus, and more particularly to a liquid level detecting apparatus capable of exchanging parts thereof.

Background Art

The related art liquid level detecting apparatuses include a liquid level detecting apparatus in which a connecting portion (land) of a wiring board and terminals are connected together by using solder (refer to, for example, JP 60-39201 U, Fig. 1 and Fig. 2).

When trouble occurs in a terminal contacting the connecting portion and a lead wire connected to this terminal in the related art liquid level detecting apparatus, the exchanging of the terminal and lead wire only cannot be done even though the terminal and lead wire only are out of order. Moreover, since the terminal is connected to the connecting portion of the wiring board, the liquid level detecting apparatus is exchanged.

In recent years, a liquid level detecting apparatus forms a unit with a fuel pump, and this unit is provided in a fuel

tank. This unitized structure necessarily accompanies the exchanging of the unitized liquid level detecting apparatus.

When the connecting portions, which are made of a material containing silver, and terminals are connected together without using solder, the silver reacts with the sulfur in a fuel to form silver sulfide. When the silver sulfide occurs between the connecting portions and terminals, the contact resistance becomes high due to the silver sulfide, and there was the possibility that the increased contact resistance caused an erroneous display on a meter.

Under the circumstances, the present invention aims at providing a liquid level detecting apparatus having detachable terminals and rarely influenced by the silver sulfide.

Disclosure of the Invention

To achieve this object, the present invention provides a liquid level detecting apparatus having a movable contact displaced in accordance with the fluctuation of a liquid level, a slide on a circuit board on which slide the movable contact is slidably moved, a resistance connected to this slide, and a connecting portions which terminals contact, a resistance value of the resistance which varies when the movable contact is slidably moved on the slide being outputted from the terminals via the connecting portions, wherein at least the sections of the connecting portions which contact the terminals

are covered with a second resistance.

The invention also provides the same liquid level detecting apparatus as described above, wherein a resistance value of the second resistance is set lower than that of the previously-mentioned resistance.

The invention further provides the same liquid level detecting apparatus as described above, wherein the second resistance contains at least ruthenium oxide (RuO_2) and has a sheet resistivity of not higher than $1.0 \Omega/\text{mm}^2$.

Brief Description of the Drawings

Fig. 1 is a front view of an embodiment of the present invention;

Fig. 2 is a side view of the same embodiment; and

Fig. 3 is a sectional view taken along the line A-A in Fig. 1.

Best Mode for Carrying Out the Invention

A liquid level detecting apparatus 1 of the present invention has a movable contact 2 displaced in accordance with the fluctuation of a liquid level, a slide 5 slidably moved at the movable contact on a circuit board 4, a resistance 7 connected to this slide 5, and a connecting portion 8 which a terminal 9 contacts, a resistance value of the resistance 7 which varies when the movable contact 2 is slidably moved

on the slide 5 being outputted from the terminal 9 via the connecting portion 8, wherein at least the section of the connecting portion 8 which contacts the terminal 9 is covered with a second resistance 16. Owing to such construction, the liquid level detecting apparatus 1 in which the terminal 9 is detachable and rarely influenced by silver sulfide can be provided.

Another liquid level detecting apparatus according to the invention is formed so that the resistance value of the second resistance 16 is set lower than that of the resistance 7. Owing to this structure, the liquid level detecting apparatus 1 in which the terminal 9 is detachable and rarely influenced by silver sulfide can be provided.

Still another liquid level detecting apparatus according to the invention is formed so that the second resistance 16 contains at least ruthenium oxide (RuO_2) and has a sheet resistivity of not higher than $1.0 \Omega/\text{mm}^2$. Owing to such a structure, the liquid level detecting apparatus 1 in which the terminal 9 is detachable and rarely influenced by silver sulfide can be provided. Since the resistance value is set low, the tolerance of resistance value occurring when the second resistance is formed can be minimized, and in its turn a detection error can be reduced to a low level.

An embodiment of the present invention will be described with reference to the attached drawings. This embodiment will

be described on the basis of a case where the present invention is applied to a liquid level detecting apparatus provided in a fuel tank of a vehicle, such as an automobile.

A liquid level detecting apparatus 1 includes first and second movable contacts 2, 3 displaced in accordance with the fluctuation of a liquid level (not shown), first and second slides 5, 6 on which the first and second movable contacts 2, 3 provided on a circuit board 4 are slidably moved, a resistance 7 connected to the first slide 5 provided also on the circuit board 4, and connecting portions 8 also provided on the circuit board 4. Terminals 9 are in contact with these connecting portions 8.

In the liquid level detecting apparatus 1, the first movable contact 2 is slidably moved on the first slide 5 to cause the resistance value of the resistance 7 to vary, and outputs this resistance value from the terminals 9 via the connecting portions 8 to meters and the like (not shown).

The first and second movable contacts 2, 3 are made of a conductive metal, such as german silver. These first and second movable contacts 2, 3 are fixed by calking to a plate type sliding member 10.

This sliding member 10 is a plate type body made of a conductive metal, and adapted to turn around a rotary shaft provided on a frame and the like (not shown) constituting the liquid level detecting apparatus 1. The sliding member 10 is

operatively connected to a float (not shown) via a member, for example, an arm and the like (not shown). The float stays on a level of a liquid fuel stored in the fuel tank, and the sliding member 10 turns in accordance with the fluctuation of the liquid level. The first and second movable contacts 2, 3 are turned with the sliding member 10 around the above-mentioned rotary shaft, and slidably moved on the first and second slides 5, 6 respectively.

The first slide 5 is formed by providing a plurality of linearly made fixed electrodes like teeth of a comb. In this embodiment, the first slide 5 is formed at the side of one end portion thereof substantially in the shape of a fan so that the first slide 5 is on a path along which the first movable contact 2 is slidably moved. The second slide 6 in this embodiment is fan-shaped so that the second slide 6 is on a path along which the second movable contact 3 is slidably moved.

The first and second slides 5, 6 are formed out of the same conductive paste in the same step. The components of this conductive paste are 80 wt% of silver and palladium and 20 wt% of glass and oxide, such as bismuth oxide. When this conductive paste is provided on the circuit board 4 by screen printing and the like and baked at a suitable temperature, the first and second slides 5, 6 are sintered. Glass and an oxide, such as bismuth oxide gather on the surface and its vicinity of the

first and second slides 5, 6 thus baked, and these slides have an excellent abrasion resistance. The first and second slides 5, 6 having an excellent abrasion resistance can be obtained.

The resistance 7 is formed out of a material containing ruthenium oxide, by providing a resistance paste on the circuit board 4 by screen printing and baking the resultant product at a suitable temperature. In this embodiment, the resistance 7 is provided astride the plural linear fixed electrodes constituting the first slide 5. The shape of the resistance 7 in this embodiment is rectangular. The shape of the resistance 7 can be set arbitrarily taking a layout on the circuit board 4 into consideration.

Referring to Fig. 1, a reference numeral 11 denotes regulating resistances, which are formed in the same step as the resistance 7. The regulating resistances 11 are connected to extensions of arbitrary fixed electrodes among the plural fixed electrodes forming the first slide 5, and provided in parallel with the resistance 7. The resistance value of the resistance 7 is regulated to an arbitrary characteristic value by changing the resistance values of the regulating resistances 11 by removed portions 12 obtained by removing parts of the regulating resistances 11 by laser trimming. Referring to Fig. 1, a reference numeral 13 denotes detecting lands which an inspection needle (not shown) of an apparatus for measuring the resistance value of the regulating resistance 11 contacts.

In this embodiment, two substantially square connecting portions 8 are formed. The thickness of the film of the connecting portions 8 is not smaller than $7.5\text{ }\mu\text{m}$. A connecting portion 8a joined to the resistance 7 is provided with a pattern 14 extending from the connecting portion 8a and joined to the resistance 7. A connecting portion 8b joined to the second slide 6 is provided with a pattern 15 extending from the connecting portion 8b and joined to the second slide 6. The connecting portions 8 and extension patterns 14, 15 are also formed out of the same conductive paste as that of the mentioned first and second slides 5, 6 in the same step.

The outer surfaces of the connecting portions 8a, 8b excluding the extension patterns 14, 15 are covered with second resistances 16. Therefore, the connecting portions 8a, 8b enable the formation of silver sulfide to be held down, and the influence of the silver sulfide to be rarely received. The material of which the second resistances 16 are made contains ruthenium oxide just as that of the resistance 7.

In this embodiment, the resistance values of the second resistances 16 are lower than that of the resistance 7. In this embodiment, the second resistances 16 contain at least ruthenium oxide (RuO_2), and have sheet resistivity of not higher than $1.0\text{ }\Omega/\text{mm}^2$. When the resistance values of the second resistances 16 are thus set low, the fluctuation of the resistance values, i.e. the tolerance of the resistance values

occurring due to the nonuniformity and the like of the second resistances 16 encountered in the formation thereof by printing can be minimized, thereby an influence on the resistance values to be outputted can be decreased and in its turn a detection error made by the liquid level detecting apparatus can be reduced to a low level.

The terminals 9 are formed by subjecting a conductive plate type metal to a process, such as a punching and bending. In this embodiment, the terminals are formed out of phosphor bronze, the outer surface of which is plated.

The terminals 9 are provided as shown in Fig. 1 and Fig. 3 with elastic contact pieces 17 contacting the connecting portions 8a, 8b of the circuit board 4. Since the connecting portions 8a, 8b are covered with second resistances 16, the contact pieces 17 contact the connecting portions 8a, 8b via the second resistances 16.

These contact pieces 17 are formed so as to be integral with the terminals 9, and provided at the portions thereof which are in the vicinity of the front ends thereof with bifurcated contact portions 18. Owing to the two bifurcated contact portions 18, the contact pieces 17 reliably come into contact with the connecting portions 8a, 8b.

The terminals 9 are provided in side surfaces 19 thereof with recesses 20 for retaining an end portion of the circuit board 4. The circuit board 4 is positioned by inserting the

end portion 4a into the recesses, and the contact portions 18 are provided so that the contact portions are reliably connected to the circuit board 4.

The terminals 9 retain lead wires 21. The retaining of the lead wires 21 is done by retaining insulating films 21a of the lead wires 21 by first calked portions 22 of the terminals 9, and by retaining wires 21b which are covered with the insulating films 21a, and which are made of a conductive metal, by second calked portions 23.

Since the present invention is formed as described above, solder and the like is not used to join the connecting portions 8a, 8b to the terminals 9, so that the detaching of the terminals 9 can be done. Moreover, the sections of the connecting portions 8a, 8b which contact the terminals 9 are covered with the second resistances 16. This enables a liquid level detecting apparatus capable of holding down the occurrence of silver sulfide in the connecting portions 8a, 8b, and in its turn rarely receiving the influence of the silver sulfide to be provided.

In the above-described embodiment, the second resistances 16 cover the surfaces of the connecting portions 8a, 8b, excluding the extension patterns 14, 15 but the present invention is not limited to the embodiment. The second resistances 16 may be formed so as to cover only the sections of the connecting portions that the contact portions 19 of the

terminals 9 contact. When the apparatus is formed in this manner, the surface area of the second resistance 16 decreases, and in its turn the manufacturing cost can be reduced.

In the above-described embodiment, the sheet resistivity of the second resistances 16 is set to not higher than $1.0 \Omega/\text{mm}^2$. The sheet resistivity can be suitably set as long as the level thereof is not higher than $1.0 \Omega/\text{mm}^2$.

Industrial Applicability

The present invention can be applied to a liquid level detecting apparatus, and suitably in particular to a liquid level detecting apparatus having detachable terminals, and capable of holding down the formation of silver sulfide.